US Army Corps of Engineers

The Hydrologic Engineering Center

GENERALIZED COMPUTER PROGRAM

INTERACTIVE NONSTRUCTURAL ANALYSIS PACKAGE

July 1981

10 December 1984

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PRELIMINARY

INTERACTIVE NONSTRUCTURAL ANALYSIS PACKAGE

July 1981

The Hydrologic Engineering Center
U. S. Army Corps of Engineers
Water Resources Support Center
Davis, CA 95616

INTERACTIVE NONSTRUCTURAL ANALYSIS PACKAGE

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INTERACTIVE NONSTRUCTURAL ANALYSIS PACKAGE

INTRODUCTION

1. PROGRAM PACKAGE ORIGIN

These programs were written at the Hydrologic Engineering Center (HEC) by David T. Ford.

2. PROGRAM PACKAGE CAPABILITIES

These programs were designed to aid in the analysis and formulation of nonstructural flood plain management plans. Damageable property is identified by an identification number. A single point may represent a single structure or group of structures.

Four types of data may be input: structure data, such as type of structure, construction material, condition; hazard data, such as location in the flood plain, depth of flooding, stage-frequency relationship; economic data, such as depth-damage relationships, value of contents or structure and; environmental data, such as indicators of special environmental, ecological, or historical significance.

The programs assist the user in sorting through all structures in the flood plain and selecting those structures of special interest. For example, all structures of wood frame in the 5-year flood plain may be selected. For any or all structures selected for analysis, detailed structure, flood hazard, economic, or environmental data may be displayed interactively. Expected annual damage is computed. The user may input modifications to the structure interactively, e.g., raise or protect, and have expected annual damage computed.

The Nonstructural Analysis Package includes two programs: a Preprocessor that creates a data bank containing various structure attributes and an Interactive Analysis Program that accesses selectively this data bank, thereby allowing evaluation of nonstructural measures. Figure 1 illustrates the sequence of events in using these programs for analysis. Prior to application of the programs, surveys are conducted to gather data necessary for the analysis, and these data are encoded for input to the Preprocessor.

The Preprocessor Program reads the encoded structure data and writes a specially-formatted data file for access by the Interactive Analysis Program. The program user must take the necessary steps to save this file on a permanent storage device on his or her computer system. In addition to the data file, the Preprocessor provides line printer output that summarizes the input data and the information that is written on the data file. This includes the expected annual damage for each damage type, computed by the Preprocessor Program using algorithms identical to those employed by the Expected Annual Damage (EAD) Program (Program 761-X6-L7580). The Preprocessor also writes a file that may be used as input to the EAD Program if the user desires to execute also that program. To accomplish that task, the user must issue appropriate system job control commands (see Table 3 for BCS control commands.)

The Interactive Analysis Program is designed to be executed from an interactive terminal, such as a cathode ray tube (CRT) terminal. The program accesses the data file written previously by the Preprocessor and provides the user with the capability to search rapidly the file to obtain information about specific structures and to evaluate the efficiency of nonstructural flood control measures. The execution of this program is controlled by the user with a set of commands, as explained elsewhere in this document. In addition to the output produced at the interactive terminal as the program executes, the Interactive Analysis Program generates a duplicate of the input commands and output results that may be disposed to a line printer by issuing appropriate job control commands (see Table 3 for example). When the effects of various nonstructural flood-control measures are simulated, the expected damage with modified conditions is computed automatically by the Interactive Analysis Program, using the algorithms form the EAD Program. In addition, a file is written to allow execution of the EAD Program with the modified depth-damage data if desired. As with the Preprocessor, the user must issue appropriate job control commands to accomplish this.

3. HARDWARE AND SOFTWARE REQUIREMENTS

The Preprocessor and Interactive Analysis Programs were written in FORTRAN IV, developed on the CDC 7600 computer, and required a random access input-output software package. The following is a list of tape assignments and memory requirements for the programs:

<u>Preprocessor Program</u>

Memory Requirements

Load:	52,000 words (octal) of core
Execute:	35,000 words (octal) of core

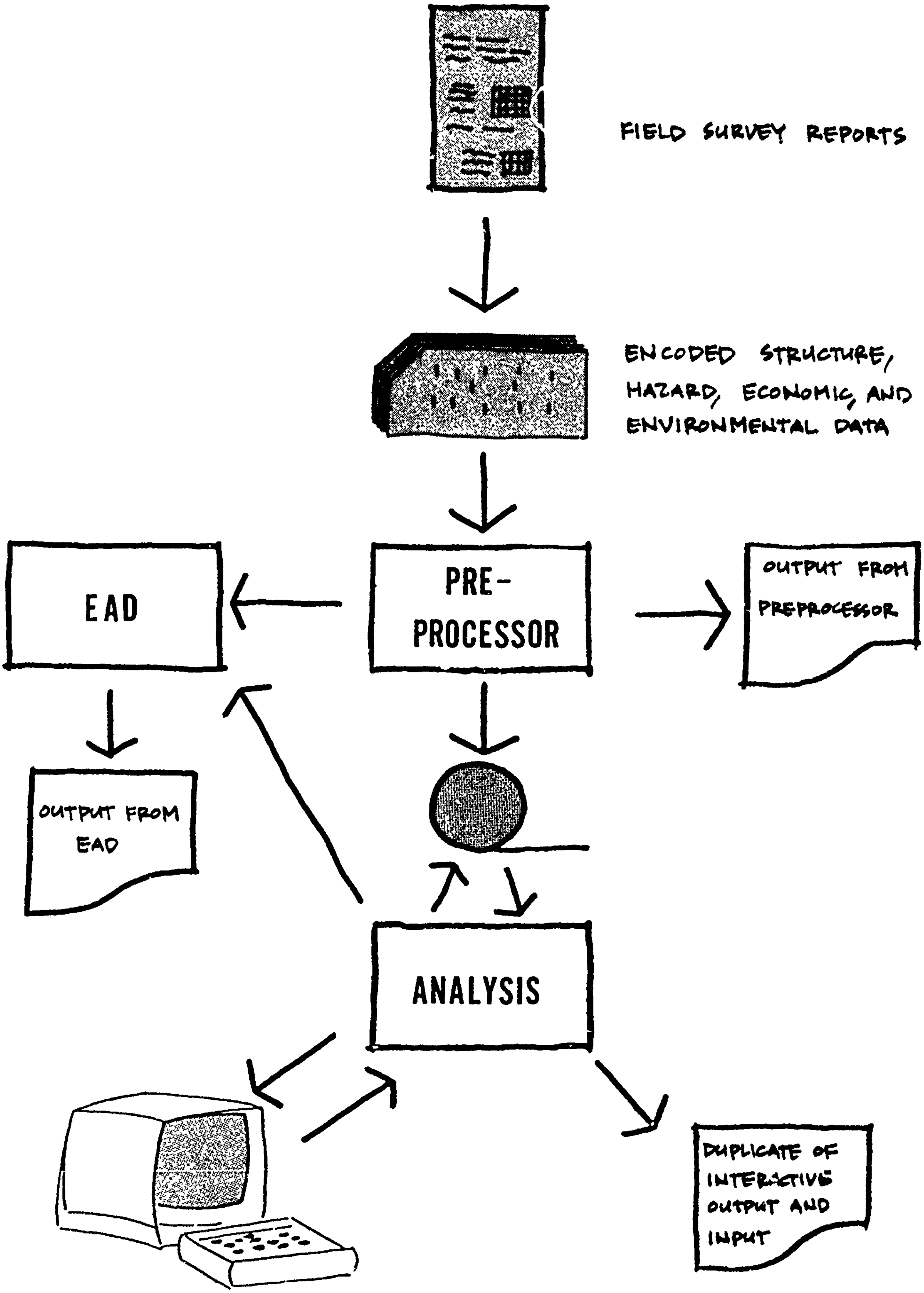

FIGURE 1
SEQUENCE OF EVENTS IN USING NONSTRUCTURAL ANALYSIS PROGRAMS

Tape Unit Assignments

Unit	Remarks
1	EAD program input data
2	Structure data bank
5	Standard card input
6	Standard line printer

Interactive Analysis Program

Memory requirements

Load: 125,000 words (octal) of core
Execute: 112,000 words (octal) of core

Tape Unit Assignments

Unit	Remarks
1	EAD program input data
2	Structure data bank
5	Standard teletype input
6	Standard teletype output
7	Scratch tape for saving standard teletype print messages for later printout on high-speed batch terminal

4. NONSTRUCTURAL ANALYSIS

To make effective use of this program the user assumes a responsibility for understanding the nature of the flood hazard, the extent of flood damage, and the physical and economic feasibility of various nonstructural measures. Reference 1 presents detailed information on these subjects. A thorough understanding of the hazard and the nonstructural measures is necessary to minimize unnecessary data collection and to maximize the opportunities for feasible nonstructural plans. With data which has a purpose in formulation and which will be used in the decision-making, and with structures or groups of structures which have possible feasible solutions, interactive analysis can be a significant aid in plan formulation.

5. INTERACTIVE COMMANDS

Valid commands for the Program for Interactive Nonstructural Analysis are:

REACH	SAVE
LIST	TERMINATE
PRINT	HELP
NUMBER	COMMENT
RAISE	RESET
PROTECT	

Each of these commands is described herein, and example applications are presented in Exhibit 4. Any unrecognizable command will cause the program to issue the message

INVALID COMMAND

6. THE REACH COMMAND

The REACH command specifies which structures are to be read from storage and analyzed by identifying the reaches that include those structures. The format of the command is

REACH *r1 r2 r3*, ect.

where *r1 r2 r3*, etc. are reach identification numbers. These identification numbers must be separated by at least one blank space. Any number of reaches may be specified by this command. For example, if the user enters the following command:

REACH 301 4 100

thereby indicating that all structures in reaches 301, 4 and 100 are to be analyzed, the program will first read data for all structures in reach 301. (Because of limitations imposed in the Preprocessor, the number of structures in this reach cannot exceed 200). If the total number of structures in reaches 301 and 4 does not exceed 200, the program will then read data for reach 4. Otherwise, reading of structure data from the data bank will terminate with only data for structures in reach 301 available for subsequent analyses. Likewise, if the total number of structures in reaches 301, 4, and 100 does not exceed 200, the data for reach 100 will be read.

As the data for structures in each reach is read, a message in the following format is printed:

REACH *r* READ. *n* STRUCTURES.

where *r* is the reach identification number, and *n* is the number of structures in that reach. If a reach identification number is specified and that reach is not included in the data bank, the following message is printed:

REACH *r* NOT FOUND

When the data for all structures in the specified reaches have been read, the program issues the message

n REACHES READ

where *n* is the number of reaches read. If any of the specified reaches are not valid (e.g., the identification is not a number), the following message will be printed:

INVALID REACH

The REACH command may be entered any number of times. Each time it is entered, the structure data currently available in the computer memory are deleted, and the data for structures in the newly specified reaches replaces it.

All other commands are ignored prior to entry of a valid REACH command, and the message

NO DATA READ

is printed.

7. THE LIST COMMAND

The LIST command directs the program to print a list of the identification numbers and names of all structures that satisfy a set of user-specified constraints. Those constraints are specified as arguments of the LIST command in the following format:

LIST *constraints*

Constraints are defined by entering a structure attribute, the type of comparison that is to be made, and the value for which the comparison is to be made. For example, to obtain a list of all structures with slab foundation, the user should enter the following command:

LIST FOUN EQ SLAB

The constraint specified here is

FOUN EQ SLAB

FOUN is the abbreviation recognized by the program for FOUNDATION, and EQ is the recognized abbreviation for EQUAL. The program will search the data for all structures included in the reaches being analyzed, will compare the foundation type of each with the word SLAB, and will produce a list of all structures that satisfy the constraint. The format of that list is as follows:

Structure ID number. Structure name

If no structures satisfy the specified constraints, the following message appears:

NO SUCH STRUCTURE

The constraints specified by the LIST command may apply to any of 37 structure attributes. These attributes and the recognized abbreviations are given as Table 1. Beyond the 4-character abbreviation listed for each attribute, all other characters are ignored. Thus the word FOUNDATION could be used in specifying the constraint. On the other hand, the order of the first four characters of a recognized abbreviation is critical.

Once the structure attribute is identified, any of three types of comparisions can be specified. These include equality (abbreviated EQ), less than or equal inequality (abbreviated LE), or greater than or equal inequality (abbreviated GE). For certain attributes, designated with an asterisk in Table 1, the inequality comparisons are meaningless because the values of these attributes are textual. For these, the program automatically assumes the comparison is to be for exact equality, and any user input other than EQ is ignored. The value for which the comparison

TABLE 1

STRUCTURE ATTRIBUTES AND ABBREVIATIONS

ABBREVIATION		ATTRIBUTE
*COND	---	CONDITION
D002	---	DEPTH OF FLOODING FOR 2-YEAR EVENT
D005	---	DEPTH OF FLOODING FOR 5-YEAR EVENT
D010	---	DEPTH OF FLOODING FOR 10-YEAR EVENT
D015	---	DEPTH OF FLOODING FOR 15-YEAR EVENT
D025	---	DEPTH OF FLOODING FOR 25-YEAR EVENT
D030	---	DEPTH OF FLOODING FOR 30-YEAR EVENT
D050	---	DEPTH OF FLOODING FOR 50-YEAR EVENT
D075	---	DEPTH OF FLOODING FOR 75-YEAR EVENT
D100	---	DEPTH OF FLOODING FOR 100-YEAR EVENT
EADC	---	EXPECTED ANNUAL DAMAGE TO CONTENTS
EADO	---	EXPECTED ANNUAL DAMAGE TO OTHER PROPERTY
EADS	---	EXPECTED ANNUAL DAMAGE TO STRUCTURE
EADT	---	TOTAL EXPECTED ANNUAL DAMAGE (ALL CATEGORIES)
*ENVI	---	ENVIRONMENTAL INFORMATION
FELE	---	FIRST-FLOOR ELEVATION OF STRUCTURE
FINT	---	RECURRENCE INTERVAL OF EVENT AT FIRST FLOOR
FOUN	---	FOUNDATION TYPE
GELE	---	GROUND ELEVATION AT STRUCTURE
*HIST	---	HISTORICAL INFORMATION
IDNO	---	IDENTIFICATION NUMBER OF STRUCTURE
LEVE	---	LEVEL OF PROTECTION
*MATF	---	CONSTRUCTION MATERIAL - FRAME
*MATS	---	CONSTRUCTION MATERIAL - SIDING
NOA1	---	NO. OPENINGS AT 1ST FLOOR
NOB1	---	NO. OPENINGS BELOW 1ST FLOOR
NWIN	---	NO. WINDOWS
PELE	---	ELEVATION FOR LEVEL OF PROTECTION
*PERM	---	PERMEABILITY
SELE	---	ELEVATION OF ZERO STAGE
*TYPE	---	TYPE OF STRUCTURE
*USEA	---	STRUCTURE USE
VCON	---	VALUE OF CONTENTS
VOTH	---	VALUE OF OTHER PROPERTY
VSTR	---	VALUE OF STRUCTURE
XCOR	---	X-COORDINATE OF STRUCTURE
YCOR	---	Y-COORDINATE OF STRUCTURE

(*indicates attribute is textual)

NOTE: Depths of flooding are measured relative to ground elevation.

is to be made (the right-hand-side of the constraint) is expressed either as a number or as alphanumeric text, depending on the attribute specified in the constraint. For comparisons with text, spelling is critical. For example, if a structure was defined as 1-STORY when the data bank was developed by the Preprocessor Program, it will not appear in a list of structures generated by the following command:

```
LIST TYPE EQ 1STORY
```

because of the difference in spelling (1-STORY vs 1STORY).

In addition to the described capability to search selectively the data for structures with attributes that satisfy a single user-defined constraint, the program also has a provision to combine constraints using the operators AND (for constraints that must be satisfied simultaneously) and OR (for alternative constraints). For example, to produce a list of all frame structures with first-floor elevation less than or equal to 710.3 feet, the user should enter the following command:

```
LIST TYPE EQ FRAME AND FELE LE 710.3
```

The program will first search the available data to identify all frame structures. Then all structures from this set that have a first-floor elevation less than or equal to 710.3 feet will be identified and listed. A maximum of three constraints can be specified with a single LIST command. If multiple constraints are specified, they are satisfied from left to right. Thus the command

```
LIST TYPE EQ FRAME AND FELE LE 710.3 OR LEVE LE 100
```

will yield a list of all frame structures with first-floor elevation less than or equal to 710.3 feet <u>plus</u> a list of all structures with level of protection less than or equal the 100-year event. No structure will appear in a list more than once.

If the constraints cannot be recognized by the program, the program issues the message

```
INVALID CONSTRAINT
```

If no constraints are specified, the program assumes that all structures that satisfied the last set of constraints specified are to be listed.

The LIST command causes no modification of the structure data in memory.

8. THE PRINT COMMAND

The PRINT command directs the program to print detailed data summaries or specific attributes for all structures that satisfy a set of user-specified constraints. The constraints are specified as described for the LIST command. If no constraints are specified, the program assumes that all structures that satisfied the last set of constraints implicitly satisfy the constraints for this command.

The type of summary or the attribute to be printed is specified by the word following the command PRINT. Valid summary types are ECONOMIC, ENVIRONMENTAL, HAZARD, and STRUCTURAL. For example, to obtain a summary of economic data for all frame structures with first-floor elevation less than or equal to 710.3 feet, the user should enter the following command:

```
PRINT ECONOMIC TYPE EQ FRAME AND FELE LE 710.3
```

The program will search the available data, and for each structure that satisfies the constraint, will print a summary that includes the structure identification number, the structure name, the value of the structure and of the contents, and the expected annual damages in all categories for current conditions and for base conditions (with no modification to the structure).

Attribute displays may be obtained for any attribute shown in Table 1. For example, to obtain a display of the current level of protection of all frame structures with first-floor elevation less than or equal to 710.3 feet, the user might enter the following command:

```
PRINT LEVEL TYPE EQ FRAME AND FELE LE 710.3
```

The program will search the available data and will print the identification number and the specified attribute for each structure that satisfies the constraints.

An example of each data summary and of an attribute display is given as Table 2. The PRINT command causes no modification of the data in memory.

TABLE 2

EXAMPLES OF SUMMARIES AVAILABLE WITH PRINT COMMAND

STRUCTURE SUMMARY - STRUCTURE 1001.
609 SECOND ST.

	CURRENT	W/P
LOP ELEV	100.00	100.00
GROUND	100.00	100.00
1ST FLOOR	101.00	101.00
ZERO STAGE	100.00	100.00
USE	RES	
TYPE	1SNB	
PERMEABLTY	HIGH	
	OPENINGS	
BELOW 1ST	0.	
AT 1ST	2.	
WINDOWS	6.	
FOUNDATION	RATS	
FRAME MATL	WOOD	
SIDE MATL	WOOD	
CONDITION	GOOD	

ECONOMIC SUMMARY - STRUCTURE 1001.
609 SECOND ST.

TYPE	VALUE	CURRENT EAD	W/P EAD	EXP ANN BENEFIT
STRUCTURE	40000.00	4393.86	4393.86	0.
CONTENTS	20000.00	3147.86	3147.86	0.
OTHER	7500.00	129.98	129.98	0.
TOTAL	67500.00	7671.70	7671.70	0.

ENVIRONMENTAL SUMMARY - STRUCTURE 1001.
609 SECOND ST.

ENVIRON	NONE
HISTORICAL	REGS

TABLE 2 (CONT.)

HAZARD SUMMARY - STRUCTURE 1001.
609 SECOND ST.

REC INT	DEPTH
2.	0.
5.	1.17
10.	1.86
15.	2.20
25.	2.66
30.	2.83
50.	3.26
75.	3.43
100.	3.86

12.	1ST FLOOR
4.	LEVEL OF PROT

PROTECTED	0.
RAISED	1.00

IDNO	LEVE
1001.	2.00
1002.	2.00
1003.	1.00
1004.	1.00
5001.	5.00
5002.	5.00
5003.	1.00
5004.	1.00
10009.	10.00
10010.	10.00
10011.	1.51
10012.	1.51
50013.	50.00
50014.	50.00
50015.	1.00
50016.	1.00
100001.	100.00
100002.	100.00
100003.	2.22
100004.	2.22

9. THE NUMBER COMMAND

The NUMBER command enables the user to determine how many structures satisfy a set of specified constraints. These constraints are specified in the format described for the LIST command. If no constraints are specified, the program assumes that all structures that satisfied the last set of constraints implicitly satisfy the constraints for this command.

When the NUMBER command is entered, the program will search the available data, counting those that satisfy the constraints. When this search is completed the message

n FEASIBLE STRUCTURES

is issued, where *n* is the number of structures that satisfy the constraints. If no structures satisfy the specified sonctraints, the following message is printed:

NO SUCH STRUCTURE

The NUMBER command causes no modification of the structure data in memory.

10. THE REVISE COMMAND

This command is no longer operational. It has been replaced with the commands RAISE and PROTECT.

11. THE RAISE COMMAND

The RAISE command allows the user to evaluate the effects of raising all structures that satisfy a set of specified constraints. These constraints are specified as described previously. If no constraints are specified, the program uses the last valid set of constraints.

The format of the RAISE command is

RAISE *d constraints*

where *d* is the distance above ground elevation that the elevation for definition of level of protection is to be raised. The relationship between the first-floor elevation, zero-stage elevation, and elevation for definition of level of protection is constant. Thus the modified zero stage elevation is the original value + Δ, where Δ is original ground elevation + *d* - original level of protection elevation. The depths for the depth-damage functions are measured from this point.

All data that are affected by raising are adjusted as appropriate, including the expected annual damage for the structure and for the contents and the level of protection. These updated values are printed in the following format when recalculated:

IDNO PELE SELE EADC EADS EADT LEVE

The expected annual damage to "other" property does not change.

Subsequent use of the RAISE command (or the PROTECT command) invalidates the efforts of all previous uses of the commands, restoring all values to base conditions before modifying them. Therefore the distance is <u>always</u> specified relative to the original elevations.

12. THE PROTECT COMMAND

The PROTECT command allows the user to evaluate the effects of protecting all structures that satisfy a set of specified constraints. These constraints are specified as described previously. If constraints are ommitted, the program uses the last valid set of constraints.

The format of the PROTECT command is

PROTECT *d constraints*

where *d* is the distance of effective protection, relative to the ground elevation at the structure. This protection may be provided by flood proofing, by constructing small walls or levees, or by applying similiar measures. The first-floor elevation and the zero-stage elevation are not modified by this command, but the elevation that defines the elevation for level of protection computations is moved to ground elevation + *d*.

All data that are affected by protecting are adjusted as appropriate, and updated values are printed in the following format:

IDNO FELE PELE SELE EADC EADS EADT LEVE

Subsequent use of the PROTECT command (or the RAISE command) invalidates the effects of all previous uses of the commands, restoring all values to base conditions before modifying them. Therefore the distance *d* is <u>always</u> specified relative to the original elevation at which damage begins.

13. THE SAVE COMMAND

The SAVE command causes updating of the data bank for all structures that satisfy a set of user-specified constraints. The constraints are specified in the same manner as described for the LIST command. If no constraints are specified, the program assumes that all structures that satisfied the last set of constraints implicitly satisfy the constraints for this command.

Figure 2 illustrates comceptually how the Program for Interactive Nonstructural Analysis operates with the data available in a structure data bank. When the user specifies, via the REACH command, which structures are to be analyzed, the program searches the data bank and copies the appropriate data for all structures in the reaches into the computer memory. As this data is revised (see the description of the RAISE and PROTECT commands), the revisions are made only to the data in memory. In order to make the changes to the data bank, the SAVE command must be executed. This causes the program to write the data that is currently in memory for the specified structures to the permanent storage medium for the data bank. Thus the user may evaluate the effects of any number of nonstructural measures before making permanent changes to the data bank.

To retain the updated data bank for later access, the user must also issue appropriate system job control commands at the termination of the interactive analysis (see the description of the TERMINATE command).

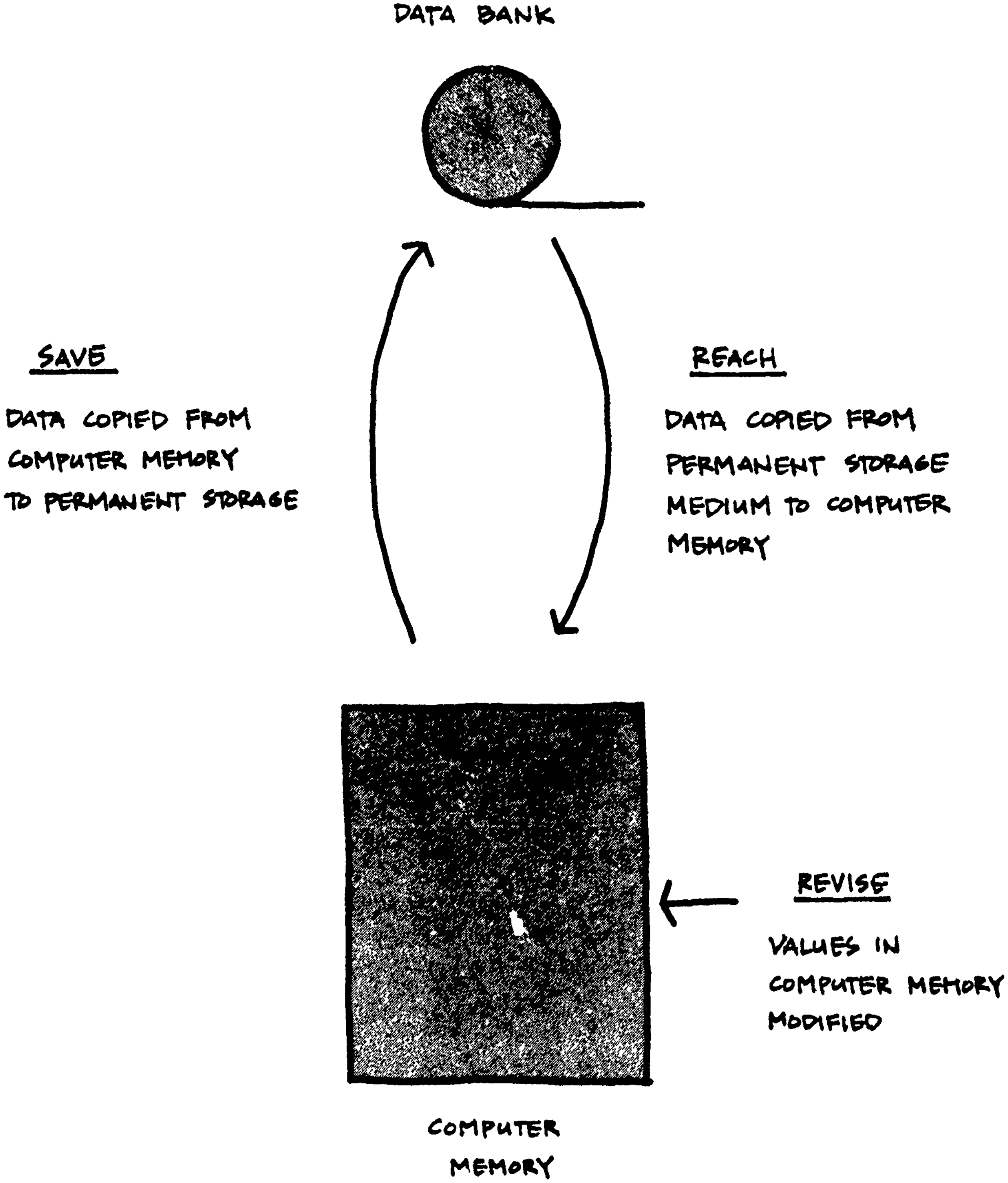

FIGURE 2

CONCEPTUAL ILLUSTRATION OF DATA MANIPULATION
BY PROGRAM FOR INTERACTIVE NONSTRUCTURAL ANALYSIS

14. THE TERMINATE COMMAND

The TERMINATE command terminates the interactive analysis of structure data. At this time, the user must issue appropriate system job control commands to process the input files generated for the EAD program by this program, to save the data bank updated by the SAVE command, or to dispose to a line printer a copy of the completed analysis. The proper job control commands to accomplish each of these tasks on the Boeing Computer System are given in Table 3.

TABLE 3

JOB CONTROL COMMANDS TO PROCESS FILES FROM PROGRAM
FOR INTERACTIVE NONSTRUCTURAL ANALYSIS (BCS SYSTEM)

To process input file for EAD program:

```
REWIND,TAPE1.

GET,EAD/UN=CECELB.

EAD,TAPE1.
```

To save updated data bank for later access:

```
REWIND,TAPE2.

REPLACE,TAPE2=(your file name)
```

To dispose a copy of the interactive analysis to a line printer:

```
REWIND,TAPE7.

DISPOSE,TAPE7=PR/EI=(your terminal identification).

[mailing information
   for BCS system
 (followed by one
    blank line)      ]
```

15. THE HELP COMMAND

This command provides the user with the following:

1. A list of a structure attributes and the accepted abbreviations for those attributes (same as Table 1 of this manual). This list is obtained by entering HELP ATTRIBUTES.

2. A brief explanation of acceptable commands for the Interactive Analysis Program. This description is obtained by entering HELP COMMANDS.

3. A brief description of the form of the constraints employed with the Interactive Analysis Program commands. This description is obtained by entering HELP CONSTRAINTS.

The information is displayed on the user's interactive terminal and is also written to a file that may later be printed with a high-speed line printer if desired.

16. THE COMMENT COMMAND

The COMMENT command allows the program user to insert comments or messages as input. These comments are ignored by the program but they provide the capability to "leave tracks" so the program user can later be reminded of any important details of the analysis.

The format of the COMMENT command is

COMMENT *any alphanumeric message*

17. THE RESET COMMAND

The RESET command restores to original values the data for all structures that satisfy a set of specified constraints. These constraints are specified as described previously. If no constraints are specified, the program uses the last valid set of constraints.

The format of the RESET command is

RESET *constraints*

The command invalidates the effects of all previous entries of the commands RAISE and PROTECT, restoring all elevations, expected annual damage values, etc. to base conditions. These base condition values are summarized in the following format for each structure:

IDNO PELE SELE EADC EADS EADT LEVE

18. COMPUTATION CONVENTIONS

The programs of the Nonstructural Analysis Package use the following conventions for development of elevation-damage functions for each structure and for calculation of expected damage:

a. Three types of damage are defined for each structure. These are (1) damage to the structure (building), (2) damage to the contents, and (3) other damage. If a structure is raised or protected, the expected annual damage to "other" property is assumed to be constant.

b. The user-defined zero-stage elevation (SELE) for each structure is the datum for all stage-damage function for the function.

c. The program pointer that defines the elevation for level of protection computations is positioned initially at the user-defined elevation, PELE. If the structure is raised a distance d, the pointer is also raised d. If the structure is protected to stage d, the pointer is positioned at GELE + d.

The interactive Analysis Program does not incorporate directly the capability to raise or to protect a structure to some specified level of protection, but this may be accomplished easily by reference to the summary generated by the command PRINT HAZARD. The stages corresponding to events of various frequencies are expressed relative to ground elevation, so the required distance for raising or protecting can be determined easily.

19. DATA CARDS

<u>TT: Title Card</u>. The title cards are used to identify the unique features of a particular job so as to jog one's memory when the output is encountered at some later time. Useful items to note on these cards are the run date, data bases, items modified from the last job, different operation mode or design feature for one or more flood plain management plans, etc. Three TT cards are required at the start of every job.

<u>DP: Stages for all Stage-Damage or Stage-Percent Damage Functions</u>. This card is used to input the stage or depth curve which corresponds to the damage or percent damage data function on the PD or DD cards. Only one DP card can be entered for each set of PD or DD cards.

<u>DF: Damage Function Name</u>. This card is used to identify the damage function which is to be input by the following PD or DD cards. In field one, a unique integer number identifies the damage function. Fields two through ten are for an alphanumeric label.

PD: Percent Damage Data. This card is used to input the percent damage data that corresponds to the depths on the DP card.

DD: Damage Data. This card is used to input the damage value data that corresponds to the depths on the DP card.

EF: End of Function Data. This card is used to signify the end of input of the damage function cards. The reach data follows this card.

RD: Reach Name. This card is used to identify the reach. An abbreviated (6 characters) identifier for the reach may appear on the other reach cards to identify the card in case one or more cards are withdrawn, either intentionally or accidently, from the rest of the data.

FR: Frequency Data. This card is used to input the necessary exceedance frequency information. The data are input in descending order and are expressed in percent, i.e., a value of 10 is input for the 10-year event, 1.0 for the 100-year event, etc. It is important that the first value be at or below the zero damage point and the last value to be an infrequent event; usually 0.1 (1,000-year event) is adequate. Anywhere from 10 to 15 points should be defined.

QF: Flow-Frequency Data. This card is used to input the flows which will correspond to the frequency values on the FR card.

EL: Datum Elevation. The datum elevation is used to adjust the depths on the stage-discharge cards to elevation data at reach index location.

SQ-QS: Stage-Flow Data. This set of cards is used to input the discharge rating curve at the index point within the present reach.

RE: Reference Flood Elevation. The reference flood elevations that apply to the reach index location are input by the use of this card.

SI: Structure Identification. This card is used to identify the structure for which the following structural data applies. On field one a unique integer number has to be used to label the structure. Fields two through ten are for an alphanumeric label.

SD: Structure Values and Damage Function. This card is used to input the structure values and the damage functions that are to be applied to each value.

SR: Reference Flood Elevation. The reference flood elevations that apply to the structure site are input by the use of this card.

SE: Structure Elevation Data. This card is used to input the ground elevation, first floor elevation, and the elevation at which damage starts.

SC: Structure Physical Characteristics. This card is used to input the physical characteristics of the structure such as permeability, number of openings foundation type, etc. The card is required, but any or all values may be omitted.

SP: Structure Site Data. This card is used to input the structure site information. The card is required, but any or all values may be omitted.

ES: End of Structure Data. This card is used to signify the end of the structure data for the present reach. The next data read will be for a new damage reach.

ER: End of Reach Data. This card signifies the end of input data for all reaches.

EXHIBIT 1

PREPROCESSOR INPUT DESCRIPTION

This exhibit contains a detailed description of the data input requirement for each variable on each input card.

The location of the variables on each input card is shown by field number. The cards are normally divided into ten fields of eight columns each except for field 1. Variables in field 1 may only occupy card columns 3 - 8 since columns 1 - 2 are reserved for the required card identification characters. Some variables are used to indicate a particular program option and the variables are integer values which must be right justified (punched on the far right side of the field) without a decimal point. Other variables are assigned numbers to express the magnitude of that variable. A "+" sign is shown under "value" and the numerical value for the variable is entered as input. Where the variable value is to be zero, the variable may be left blank, since a blank field is read as zero and any number without a sign is considered positive.

Unless noted otherwise, variable names beginning with the leters I, J, K, L, M or N represent integer variables and a decimal point must not appear in the field. All others are floating point variables and may either have a decimal point or be right justified.

The location of variables on cards is often referred to by an abbreviated designation, for example, SE.5 means the fifth field of the SE card.

TT Card - Title Card

Field	Variable	Value	Description
1 - 10	--	Alpha	Alphanumeric information to identify the job. The TT cards will be printed at the top of first output page. Three TT cards are required for the input.

DP Card - Depth - Damage or Depth - Percent Damage Data (Required Card)

Field	Variable	Value	Description
1	--	---	Not used.
2	NDMV	+	The number of depth values that are to be input. Maximum 18.
3	STAGEF(1)	$\mp$	Depth, relative to elevation at which damage starts (SE.4). STAGEF(1) should correspond to the elevation.
4 - 10	STAGEF (2 - NDMV)	$\mp$	Repeat as required by NDMV. If there are more than eight values, the ninth value must begin in the first field of the next card.

DF Card - Damage Function Name (Required Card)

Field	Variable	Value	Description
1	IT	+	Value to be used to identify the damage function on the SD card.
2 - 10	KNDMF	Alpha	Alphanumeric title to label the damage function.

PD or DD Card - Percent Damage/Damage Data (Required Card)

Field	Variable	Value	Description
1 - 2	--	---	Not used.
3 - 10	DAMGF (1-NDMV)	+	Percent damages (PD card) or damage values (DD card) that correspond to the depths on the DP card. Initial value should be zero. If there are more than eight values, the ninth value must begin in the first field of the next card.

EF Card - End of Damage Function (Required Card). Identifies end of damage function input.

Field	Variable	Value	Description
1 - 10	--	---	Not used.

RD Card - Reach Name (Required Card)

Field	Variable	Value	Description
1	IDRCH	+	Value to be used to identify the reach.
2 - 10	KNRCH	Alpha	Alphanumeric title for the reach.

FR Card - Frequency Data

Field	Variable	Value	Description
1		Alpha	A brief reach identification (or station number) to identify the data. May be left blank if desired.
2	NFRQ	+	The number of exceedance frequency values that are to be input for computation of expected annual damage. Maximum 18.
3	FREQ(1)	+	Exceedance frequency values (in percent). Values must be in descending order (99., 90., . . . 10. for the 10-year event, 1.0 for the 100-year event, etc.).
4 - 10	FREQ (2 - NFRQ)	+	Repeat as required by NFRQ. If there are more than eight values, the ninth value must begin in the first field of the next card.

QF Card - Flow (Frequency) Data (Required Card)

Field	Variable	Value	Description
1		Alpha	A brief reach identification (or station number) to identify the data. May be left blank if desired.
2	--	---	Not used.
3	QFRQ(1)	+	Peak flood values. Must correspond to exceedance frequency values (FR card).
4 - 10	QFRQ (2 - NFRQ)	+	Repeat as required by NFRQ. If more than eight values, the ninth value must begin in the first field of the next card.

EL Card - Index Location Datum Elevation (Required Card)

Field	Variable	Value	Description
1	--	---	Not used.
2	ELEVD	∓	The datum elevation of the index location which will be used to adjust the stages on the stage-discharge cards to elevations.
3 - 10	--	---	Not used.

SQ Card - Stage (Flow) Data (Required Card)

Field	Variable	Value	Description
1	--	---	Not used.
2	NSTG	+	The number of stage (and corresponding flow) values that are to be input. Dimensioned for 18.
3	STGQ(1)	+	Stage values relative to ELEVD (EL.2) corresponding to flow values on the QS card. Values must be in ascending order.
4 - 10	STGQ (2 - NSTG)	+	Repeat as required by NSTG. If more than eight values, the ninth value must begin in the first field of the next card.

QS Card -- Flow (Stage) Data (Required Card)

Field	Variable	Value	Description
1 - 2	--	---	Not used.
3	QSTG(1)	+	Discnarge values corresponding to the stages on the SQ card.
4 - 10	QSTG (2 NSTG)	+	Repeat as required by NSTG. If more than eight values, the ninth value must begin in the first field of the next card.

RE Card - Reference Flood Elevations at Reach Index Location (Required Card)

Field	Variable	Value	Description
1	--	---	Not used.
2	NRFREQ	+	The number of reference flood elevations to be read.
3 - 10	RELV (1 - NRFREQ)	∓	The reference flood elevations that apply at the index locations. If more than eight values, the ninth value must begin in the first field of the next card.

SI Card - Structure ID Card (Required Card)

Field	Variable	Value	Description
1	IDSTR	+	Unique structure identification number.
2 - 10	KNSTR	Alpha	The alphanumeric label to describe the structure.

SD Card - Structure Values and Damage Functions (Required Card)

Field	Variable	Value	Description
1	--	---	Not used.
2	VSTR	+	Total value of structure. If damage function to be assigned to this value is a percent damage function (PD Card), this value provides conversion. If DD Card used, enter 1 for VALS.
3	IDFS	+	Identification code for damage function for structure damage. Use appropriate identifier (IT) from DF Cards.
4	VCON	+	Total value of contents if PD Card used. Otherwise, enter 1.
5	IDFC	+	Identification code for contents damage function. Use appropriate identifier (IT) from DF Cards.
6	VOTH	+	Total value of "other" damageable items. If PD Card used. Otherwise, enter 1.
7	IDFO	+	Identification code for Damage function applicable to "other" items. Use appropriate identifier (IT) from DF Cards.

SR Card - Reference Flood Elevation at Structure (Required Card)

Field	Variable	Value	Description
1	--	---	Not used.
2	RSELV(1)	∓	The reference flood elevation corresponding to RELV(1) (RE.3) that applies at the structure.
3 - 10	RSELV (2 - NRFREQ)		Repeat as required for NRFREQ values. If more than nine values, the tenth value must begin in the first field of the next card.

SE Card - Structure Elevation Data (Required Card)

Field	Variable	Value	Description
1	PELE	$\mp$	Elevation at which level of protection pointer is fixed for base conditions.
2	GELE	$\mp$	Ground elevation of structure.
3	FELE	$\mp$	First floor elevation of structure.
4	SELE	$\mp$	Zero-stage elevation of structure. This elevation corresponds to stage = 0 for all stage-damage functions for this structure.
5	XCOR	$\mp$	The x-coordinate of the structure. Any rectilinear coordinate system is acceptable.
6	YCOR	$\mp$	The y-coordinate of the structure.

SC Card - Physical Characteristics of Structure (Required Card)
Any or all values may be omitted.

Field	Variable	Value	Description
1	USED	Alpha	The present use of the structure (left justify).
2	TYPE	Alpha	The type of structure (left justify).
3	PERM	Alpha	The permeability of the structure.
4	NOB1	+	Number of openings below first floor.
5	NOA1	+	Number of openings at first floor.
6	NWIN	+	Number of windows.
7	FOUN	Alpha	Foundation type (left justify).
8	MATF	Alpha	Frame material (left justify).
9	MATS	Alpha	Siding material (left justify).
10	COND	Alpha	Condition of structure (left justify).

SP Card - Structure Site Data and Initial Feasibility Assessment (Required Card)

Field	Variable	Value	Description
1	HIST	Alpha	Historic site identification (left justify).
2	ENVI	Alpha	Environmentally significant site identification (left justify).
3-10	--	--	Not used.

ES Card - End of Structure Data (Required Card). Identifies end of structure data input for this reach.

Field	Variable	Value	Description
1 - 10	--	---	Not used.

ER Card - End of Run Card (Required Card). Identifies end of input.

Field	Variable	Value	Description
1 - 10	--	---	Not used.

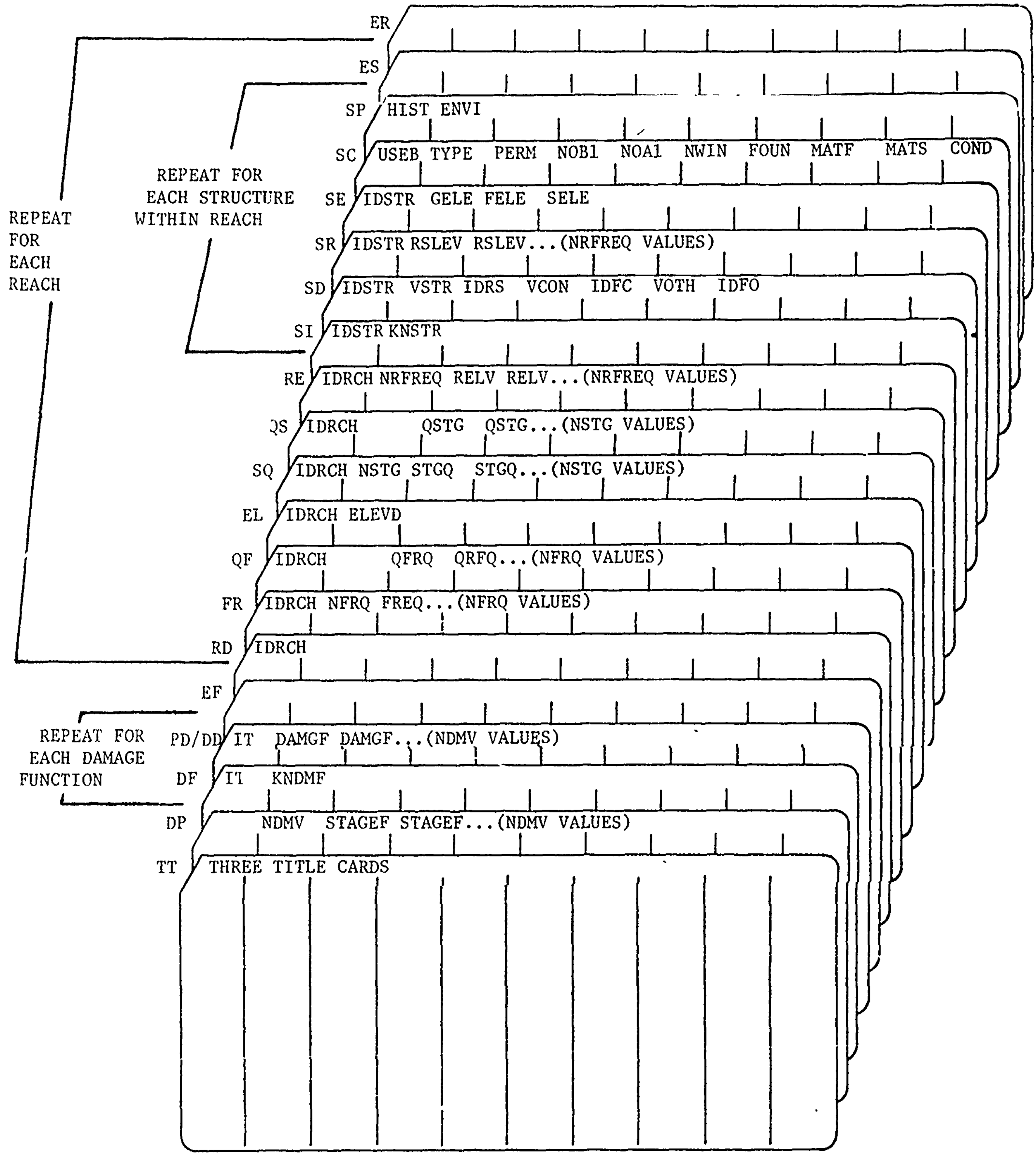
ER
ES
SP
HIST ENVI
SC
USEB TYPE PERM NOB1 NOA1 NWIN FOUN MATF MATS COND
REPEAT FOR EACH STRUCTURE WITHIN REACH
SE
IDSTR GELE FELE SELE
REPEAT FOR EACH REACH
SR
IDSTR RSLEV RSLEV...(NRFREQ VALUES)
SD
IDSTR VSTR IDRS VCON IDFC VOTH IDFO
SI
IDSTR KNSTR
RE
IDRCH NRFREQ RELV RELV...(NRFREQ VALUES)
QS
IDRCH QSTG QSTG...(NSTG VALUES)
SQ
IDRCH NSTG STGQ STGQ...(NSTG VALUES)
EL
IDRCH ELEVD
QF
IDRCH QFRQ QRFQ...(NFRQ VALUES)
FR
IDRCH NFRQ FREQ...(NFRQ VALUES)
RD
IDRCH
EF
REPEAT FOR EACH DAMAGE FUNCTION
PD/DD
IT DAMGF DAMGF...(NDMV VALUES)
DF
IT KNDMF
DP
NDMV STAGEF STAGEF...(NDMV VALUES)
TT
THREE TITLE CARDS

EXHIBIT 2

SAMPLE INPUT FOR PREPROCESSOR

The example problem presented in this exhibit and in Exhibits 3 and 4 demonstrates the capabilities of the Nonstructural Analysis Package and illustrates the input to and output from the programs. The hypothetical flood plain to be analyzed is divided into four reaches identified as 2, 5, 10, 50, and 1000. Each reach includes four structures. Nine depth-percent damage functions are specified.

The pages following in this exhibit show the input to the Preprocessor program for the example problem. Several items of this list of input cards are identified with circled numbers; these correspond to the paragraphs that follow.

1. Three required title cards are provided.

2. Eighteen depth values are defined for the depth-damage or depth-percent damage relationships.

3. Nine damage functions are specified. Here percent damage values are given on PD cards. The EF card signifies the end of damage function input.

4. The RD card identifies the beginning of input for a reach. For Reach 2, 14 values of the discharge-frequency function are defined on the FR and QF cards. Also, 14 values of the stage-discharge relationship are defined with the SQ and QS cards. One reference flood elevation is defined with the RE card.

5. Structure 1001 is the first structure identified in Reach 2. The SD, SR, SE, and SP cards specify the required values. Additional structures in Reach 2 are 1002, 1003, and 1004. The end of structure data for the reach is indicated with the ES card.

6. The RD card again indicates the beginning of data for another reach. The structure data is specified on SI, SD, SR, SE, SC, and SP cards, and the end of the structure data for the reach is identified with the ES card.

7. The end of data for all reaches is identified with the ER card.

```
TTTEST PROBLEM FOR PROGRAM FOR INTERACTIVE NONSTRUCTURAL ANALYSIS        1
TTJUNE 1981 VERSION
TTDEPTH-DAMAGE DATA BASED ON FIA DATA
DP            18      -8      -1       0      .1       1       2       3       4       2
DP     5       6       7       8       9      10      11      12      13      15
DF     11-STORY, NO BASEMENT, STRUCTURE DAMAGE
PD                     0       0       4       8      22      30      35      39
PD    41      44      46      48      50      50      50      50      50      50
DF     21-STORY, NO BASEMENT, CONTENTS DAMAGE
PD                     0       0       0       5      35      50      60      68
PD    74      78      81      83      85      85      85      85      85      85
DF     32-STORY, NO BASEMENT, STRUCTURE DAMAGE
PD                     0       0       2       4      10      16      20      24
PD    27      30      32      34      39      42      45      47      49      50
DF     42-STORY, NO BASEMENT, CONTENTS DAMAGE
PD                     0       0       0       5      16      28      37      43
PD    47      49      50      51      55      58      65      72      78      80
DF     51-STORY, WITH BASEMENT, STRUCTURE DAMAGE
PD                     0    5.25       6      10      24      31      37      41      3
PD    44      46      48      49      50      50      50      50      50      50
DF     62-STORY, WITH BASEMENT, CONTENTS DAMAGE
PD                     0       7       8      21      40      58      70      76
PD    80      82      83      85      85      85      85      85      85      85
DF     72-STORY, WITH BASEMENT, STRUCTURE DAMAGE
PD                     0   4.375       5       7      14      21      26      30
PD    33      35      38      40      44      46      47      48      49      50
DF     82-STORY, WITH BASEMENT, CONTENTS DAMAGE
PD                     0   4.375       5      10      22      34      43      48
PD    51      52      53      56      59      64      71      76      78      80
DF     9GARAGE, GROUNDS, FENCE, DRIVE, LAWN
PD                     0       0       0       0       5       5       5       5
PD     5       5       5       5       5       5       5       5       5       5
EF
RD     2FORD FREEWAY BRIDGE TO WKJ WAY   4
FR     2      14     100      50      20      10    6.67       5       4    3.33
FR   2.5       2    1.33       1      .5      .2
QF     2             100     200     300     400     500     600     700     800
QF   900    1000    1100    1200    1300    1400
EL             0
SQ            14    98.6     100  101.17  101.86   102.2  102.46  102.66  102.83
SQ103.08  103.26  103.63  103.86  104.43  105.06
QS                   100     200     300     400     500     600     700     800
QS   900    1000    1100    1200    1300    1400
```

```
RE               1      100       (5)
SI  1001609 SECOND ST.
SD           40000        1    20000        2     7500        9
SR               100
SE   100       100      101      100   518102 1502300
SCRES    1SNB     HIGH             0        2         6RAISED  WOOD     WOOD     GOOD
SFREGS  NONE
SI  1002610 SECOND ST.
SD           50000        3    25000        4     7500        9
SR               100
SE   100       100      101      100   518517 1502511
SCRES    2SNB     HIGH             0        2        10RAISED  WOOD     WOOD     GOOD
SPNONE  NONE
SI  1003611 SECOND ST.
SD           50000        5    25000        6     7500        9
SR               100
SE    93       100      101       93   519307 1503062
SCRES    1SWB     HIGH             0        2         6SLAB    WOOD     WOOD     GOOD
SPNONE  NONE
SI  1004612 SECOND ST.
SD           80000        7    40000        8
SR               100
SE    93       100      101       93   519719 1503329
SCRES    2SWB     HIGH             0        2        10SLAB    WOOD     WOOD     POOR
SPNONE  NONE
ES
RD      5WKJ WAY TO DAVIS DRIVE      (6)
FR      2        14       100       50       20       10     6.67        5        4     3.33
FR    2.5         2      1.33        1       .5       .2
QF      2                 100      200      300      400      500      600      700      800
QF    900      1000      1100     1200     1300     1400
EL                0
SQ               14      96.5     98.1      100    101.4   102.14   102.67   103.07    103.4
SQ 103.9   104.27    104.91    105.4   106.54    107.8
QS                        100      200      300      400      500      600      700      800
QS    900      1000      1100     1200     1300     1400
RE                1       100
SI  50011104 F ST.
SD           40000        1    20000        2     6000        9
SR               100
SE   100       100      101      100   520001 1503516
SCRES    1SNB     HIGH             0        2         6RAISED  WOOD     WOOD     GOOD
SPNONE  FUEL
SI  50021105 F ST.
```

```
SD          50000       3   25000       4    7500       9
SR            100
SE   100      100     101     100  520207 1503516
SCRES   2SNB    HIGH            0       2      10RAISED  WOOD    WOOD    POOR
SFNONE  NONE
SI  50031106 F ST.
SD          50000       5   25000       6
SR            100
SE    93      100     101      93  520413 1503679
SCRES   1SWB    HIGH            0       2        6SLAB   WOOD    WOOD    GOOD
SFNONE  NONE
SI  50041107 F ST.
SD          80000       7   40000       8   12000       9
SR            100
SE    93      100     101      93  520519 1503822
SCRES   2SWB    HIGH            0       2       10SLAB   WOOD    WOOD    GOOD
SFREGS  FUEL
ES
RD    10DAVIS DRIVE TO BARKIN BLVD. BRIDGE
FR     2       14     100      50      20      10    6.67       5       4    3.33
FR   2.5        2    1.33       1      .5      .2
QF     2              100     200     300     400     500     600     700     800
QF   900     1000    1100    1200    1300    1400
EL              0
SQ             14    91.6    94.2   97.58     100   101.5   102.5  103.24  103.89
SQ104.85   105.63     107     108  110.15   112.3
QS                    100     200     300     400     500     600     700     800
QS   900     1000    1100    1200    1300    1400
RE              1     100
SI 100091211 CALIFORNIA ST.
SD          40000       1   20000       2
SR            100
SE   100      100     101     100  521311 1504419
SCRES   1SNB    LOW             0       2        6SLAB   BRICK   BRICK   GOOD
SFREGS  NONE
SI 100101212 CALIFORNIA ST.
SD          50000       3   25000       4    7500       9
SR            100
SE   100      100     101     100  521501 1504423
SCRES   2SNB    LOW             0       2       10SLAB   BRICK   BRICK   POOR
SFNONE  NONE
SI 100111213 CALIFORNIA ST.
SD          50000       5   25000       6
SR            100
```

```
SE    93     100     101       93  521502 1504427
SCRES   1SWB    LOW              0       2        6SLAB    BRICK    BRICK    GOOD
SFNONE  NONE
SI 100121214 CALIFORNIA ST.
SD          80000       7   40000        8   12000        9
SR              100
SE    93     100     101       93  521907 1504852
SCRES   2SWB    LOW              0       2       10SLAB    BRICK    BRICK    GOOD
SFREGS  NONE
ES
RD    50BARKIN BLVD. BRIDGE TO BURNHAM BLVD.
FR     2      14     100      50      20      10    6.67       5       4    3.33
FR   2.5       2    1.33       1      .5      .2
QF     2             100     200     300     400     500     600     700     800
QF   900    1000    1100    1200    1300    1400
EL             0
SQ            14    95.4   96.74   97.91    98.6   98.94    99.2    99.4   99.57
SQ 99.82     100  100.37   100.6  101.17   101.8
QS                   100     200     300     400     500     600     700     800
QS   900    1000    1100    1200    1300    1400
RE             1     100
SI 500131411 REDWOOD AVE.
SD          40000       1   20000        2    6600        9
SR              100
SE   100     100     101      100  522489 1504997
SCRES   1SNB    LOW              0       2        6SLAB    BRICK    BRICK    GOOD
SPSTHS  NONE
SI 500141413 REDWOOD AVE.
SD          50000       3   25000        4
SR              100
SE   100     100     101      100  522710 1505236
SCRES   2SNB    LOW              0       2       10SLAB    BRICK    BRICK    GOOD
SFNONE  NONE
SI 500151415 REDWOOD AVE.
SD          50000       5   25000        6
SR              100
SE    93     100     101       93  522946 1505422
SCRES   1SWB    LOW              0       2        6SLAB    BRICK    BRICK    GOOD
SPSTHS  NONE
SI 500161417 REDWOOD AVE.
SD          80000       7   40000        8
SR              100
SE    93     100     101       93  323098 1505666
SCRES   2SWB    LOW              0       2       10SLAB    BRICK    BRICK    GOOD
```

```
SFNONE  NONE
ES
RD  1000BURNHAM BLVD. TO PENNI LANE
FR     2       14      100       50       20       10     6.67        5        4     3.33
FR   2.5        2     1.33        1       .5       .2
QF     2               100      200      300      400      500      600      700      800
QF   900     1000     1100     1200     1300     1400
EL              0
SQ             14     91.1     92.7     94.6       96    96.74    97.27    97.67       98
SQ  98.5    98.87    99.51      100   101.14    102.4
QS                     100      200      300      400      500      600      700      800
QS   900     1000     1100     1200     1300     1400
RE              1      100
SI1000012425 YOSEMITE DR.
SD          40000        1    20000        2     8000        9
SR            100
SE   100      100      101      100   523808 1506213
SCRES   1SNB    HIGH              0        2        6RAISED  WOOD     WOOD     GOOD
SFNONE  NONE
SI1000022426 YOSEMITE DR.
SD          50000        3    25000        4
SR            100
SE   100      100      101      100   523912 1506214
SCRES   2SNB    HIGH              0        2       10RAISED  WOOD     WOOD     POOR
SFNONE  SEPT
SI1000032428 YOSEMITE DR.
SD          50000        5    25000        6
SR            100
SE    93      100      101       93   523416 1506205
SCRES   1SWB    HIGH              0        2        6SLAB    WOOD     WOOD     GOOD
SFNONE  NONE
SI1000042500 YOSEMITE DR.
SD          80000        7    40000        8    12000        9
SR            100
SE    93      100      101       93   523521 1506201
SCRES   2SWB    HIGH              0        2       10SLAB    WOOD     WOOD     GOOD
SFNONE  SEPT
ES
ER
```

7

EXHIBIT 3

EXAMPLE OUTPUT FROM PREPROCESSOR

The pages following include selected portions of the output from the Preprocessor program for the input shown as Exhibit 2. Certain items of this output are identified with circled numbers; these correspond to the paragraphs that follow.

1. The job title (3 cards) is printed. This same title is stored in the data bank created by the preprocessor program.

2-3. For each user-defined depth-damage function, the input name, depth, and damages (or percent damages) are printed. The depths are constant for all functions.

4. The reach identification number and name are printed, followed by data for the reach index point, followed by data for all structures in the reach.

5. The input discharge-frequency relationship at the reach index point is printed for verification.

6. The input datum elevation, to be added to stage values at the index point, is printed for verification.

7. The input stage-discharge relationship at the reach index point is printed.

8. Stage values corresponding to the discharge values specified for the discharge-frequency relationship are determined by interpolation and are printed.

9. The input reference flood elevations are shown for verification. These elevations are used to establish a relationship of water surface elevations at the reach index point to water surface elevations at the structures in the reach.

10. The structure identification and title is printed.

11. For each of the three damage types, the value and specified depth-damage relationship is shown.

12. The reference flood elevations at the structure are shown. These are used with the reference flood elevations for the index point to develop the required frequency curve at the structure.

13. The various user-identified elevations at the structure are printed, along with the frequency of the event with water surface corresponding to the level of protection elevation. These frequencies are determined by interpolation.

14. The level of protection is shown. This is the recurrence interval, in years, of the event corresponding to the user identified level of protection elevation (identified as LOP ELEV in item 13).

15. Other input structure attributes are shown for verification.

16. The computer elevation-frequency function for the structure is tabulated. This function is determined by "transferring" the elevation-frequency function for the index point to the structure via the reference flood elevation relationship.

17. The computed stages, relative to ground elevation at the structure, are shown for the 2, 5, 10, 15, 25, 30, 50, 75, and 100 - year events.

18. The stage-damage functions for the three damage types are tabulated, and a total damage function is shown. The stages are those specified with the stage vs. percent damage relationships.

19. The expected values of annual damages, by type, and the total expected annual damage are tabulated.

```
++++++++++++++++++++++++++++++++++++
+ STRUCTURE INVENTORY PREPROCESSOR +
++++++++++++++++++++++++++++++++++++
TEST PROBLEM FOR PROGRAM FOR INTERACTIVE NONSTRUCTURAL ANALYSIS          1
JUNE 1981 VERSION
DEPTH-DAMAGE DATA BASED ON FIA DATA

DAMAGE FUNCTION  1     1-STORY, NO BASEMENT, STRUCTURE DAMAGE

STAGE
     -8.00     -1.00     0.         .10      1.00      2.00      3.00      4.00      5.00      6.00          2
      7.00      8.00     9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        0.       4.00      3.00     22.00     30.00     35.00     39.00     41.00     44.00          3
     46.00     48.00    50.00     50.00     50.00     50.00     50.00     50.00

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

DAMAGE FUNCTION  2     1-STORY, NO BASEMENT, CONTENTS DAMAGE

STAGE
     -8.00     -1.00     0.         .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00     9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        0.       0.        5.00     35.00     50.00     60.00     68.00     74.00     78.00
     81.00     83.00    85.00     85.00     85.00     85.00     85.00     85.00

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

DAMAGE FUNCTION  3     2-STORY, NO BASEMENT, STRUCTURE DAMAGE

STAGE
     -8.00     -1.00     0.         .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00     9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        0.       2.00      4.00     10.00     16.00     20.00     24.00     27.00     30.00
     32.00     34.00    39.00     42.00     45.00     47.00     49.00     50.00

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```

```
DAMAGE FUNCTION  4     2-STORY, NO BASEMENT, CONTENTS DAMAGE

STAGE
     -8.00     -1.00      0.         .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00      9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        0.        0.        5.00     16.00     28.00     37.00     43.00     47.00     49.00
     50.00     51.00     55.00     58.00     65.00     72.00     78.00     80.00

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

DAMAGE FUNCTION  5     1-STORY, WITH BASEMENT, STRUCTURE DAMAGE

STAGE
     -8.00     -1.00      0.         .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00      9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        5.25      6.00     10.00     24.00     31.00     37.00     41.00     44.00     46.00
     48.00     49.00     50.00     50.00     50.00     50.00     50.00     50.00

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DAMAGE FUNCTION  6     2-STORY, WITH BASEMENT, CONTENTS DAMAGE

STAGE
     -8.00     -1.00      0.         .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00      9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        7.00      8.00     21.00     40.00     58.00     70.00     76.00     80.00     82.00
     83.00     85.00     85.00     85.00     85.00     85.00     85.00     85.00

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
DAMAGE FUNCTION  7     2-STORY, WITH BASEMENT, STRUCTURE DAMAGE

STAGE
     -8.00     -1.00      0.        .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00      9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        4.38      5.00      7.00     14.00     21.00     26.00     30.00     33.00     35.00
     38.00     40.00     44.00     46.00     47.00     48.00     49.00     50.00

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DAMAGE FUNCTION  8     2-STORY, WITH BASEMENT, CONTENTS DAMAGE

STAGE
     -8.00     -1.00      0.        .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00      9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        4.38      5.00     10.00     22.00     34.00     43.00     48.00     51.00     52.00
     53.00     56.00     59.00     64.00     71.00     76.00     78.00     80.00

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DAMAGE FUNCTION  9     GARAGE, GROUNDS, FENCE, DRIVE, LAWN

STAGE
     -8.00     -1.00      0.        .10      1.00      2.00      3.00      4.00      5.00      6.00
      7.00      8.00      9.00     10.00     11.00     12.00     13.00     15.00

PERCENT DAMAGE
      0.        0.        0.        0.       5.00      5.00      5.00      5.00      5.00      5.00
      5.00      5.00      5.00      5.00      5.00      5.00      5.00      5.00

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***** SWITCH INDEX TO IDXB
```

```
REACH    2     FORD FREEWAY BRIDGE TO WKJ WAY          4

FREQUENCIES
    100.00     50.00     20.00     10.00      6.67      5.00      4.00      3.33      2.50      2.00      5
      1.33      1.00       .50       .20

FLOOD PEAKS
      100.      200.      300.      400.      500.      600.      700.      800.      900.     1000.
     1100.     1200.     1300.     1400.

DATUM ELEVATION
      0.                   6

STAGES FOR RATING CURVE
     98.60    100.00    101.17    101.86    102.20    102.46    102.66    102.83    103.08    103.26      7
    103.63    103.86    104.43    105.06

FLOWS FOR RATING CURVE
      100.      200.      300.      400.      500.      600.      700.      800.      900.     1000.
     1100.     1200.     1300.     1400.

STAGES FOR FLOOD PEAKS
     98.60    100.00    101.17    101.86    102.20    102.46    102.66    102.83    103.08    103.26      8
    103.63    103.86    104.43    105.06

REFERENCE FLOOD ELEVATIONS
    100.00                      9

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
STRUCTURE  1001      609 SECOND ST.          (10)

       TYPE      VALUE  FUNCTION
  STRUCTURE     40000.         1             (11)
   CONTENTS     20000.         2
      OTHER      7500.         9

REFERENCE FLOOD ELEVATIONS AT STRUCTURE      (12)
    100.00

                 ELEV       FREQ
   LOP ELEV    100.00     50.000      (13)
     GROUND    100.00     50.000
  1ST FLOOR    101.00     23.414
 ZERO STAGE    100.00     50.000

LEVEL OF PROTECTION         (14)
     2.000

    X-COORD 518102.00       (15)
    Y-COORD1502300.00
        USE       RES
       TYPE      1SNB
 PERMEABLTY      HIGH

             OPENINGS
  BELOW 1ST         0
     AT 1ST         2
    WINDOWS         6

 FOUNDATION      RAIS
 FRAME MATL      WOOD
  SIDE MATL      WOOD
  CONDITION      GOOD

 HISTORICAL      REGS
    ENVIRON      NONE
```

FREQ	ELEV	STAGE (GROUND)	STAGE (0 STAGE)
100.000	98.60	-1.40	-1.40
50.000	100.00	0.	0.
20.000	101.17	1.17	1.17
10.000	101.86	1.86	1.86
6.670	102.20	2.20	2.20
5.000	102.46	2.46	2.46
4.000	102.66	2.66	2.66
3.330	102.83	2.83	2.83
2.500	103.08	3.08	3.08
2.000	103.26	3.26	3.26
1.330	103.63	3.63	3.63
1.000	103.86	3.86	3.86
.500	104.43	4.43	4.43
.200	105.06	5.06	5.06

16

REC INT (YRS)	STAGE (GROUND)
2.	0.
5.	1.17
10.	1.86
15.	2.20
25.	2.66
30.	2.83
50.	3.26
75.	3.63
100.	3.86

17

STAGE	STRUCTURE	CONTENTS	OTHER	TOTAL
-8.00	0.	0.	0.	0.
-1.00	0.	0.	0.	0.
0.	1600.00	0.	0.	1600.00
.10	3200.00	1000.00	0.	4200.00
1.00	8800.00	7000.00	375.00	16175.00
2.00	12000.00	10000.00	375.00	22375.00
3.00	14000.00	12000.00	375.00	26375.00
4.00	15600.00	13600.00	375.00	29575.00
5.00	16400.00	14800.00	375.00	31575.00
6.00	17600.00	15600.00	375.00	33575.00
7.00	18400.00	16200.00	375.00	34975.00
8.00	19200.00	16600.00	375.00	36175.00
9.00	20000.00	17000.00	375.00	37375.00
10.00	20000.00	17000.00	375.00	37375.00
11.00	20000.00	17000.00	375.00	37375.00
12.00	20000.00	17000.00	375.00	37375.00
13.00	20000.00	17000.00	375.00	37375.00
15.00	20000.00	17000.00	375.00	37375.00
EAD	4393.86	3147.86	129.98	7671.70

18

19

```
***** SWITCH INDEX TO IDXP

***** WRITMS, RECORD      1

***** SWITCH INDEX TO IDXS

***** WRITMS, RECORD      1

(      1001        69        185)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

REMAINDER OF OUTPUT OMITTED

EXHIBIT 4

INTERACTIVE ANALYSIS PROGRAM EXAMPLES

The pages following show examples of the Interactive Analysis program. Each command entered by the program user is preceded by **** for ease of identification and is indexed with a circled number. These numbers correspond to the numbered paragraphs that follow.

1. The COMMAND command is used to print a message.

2. HELP COMMAND yields a brief summary of the available commands.

3. HELP CONSTRAINTS yields a summary of the format of the constraints used with the various program commands.

4. Data are read from the data bank for structures in reaches 2, 5, 10, 50, 1000. The number of structures in each is identified, and the total number of reaches for which data are read is printed. The total number of structures for which data are read will not exceed 200; therefore the number of reaches for which data are read may be less than the number specified by the user. Any reach identification numbers for which data are not found are ignored.

5. The value of the structure (VSTR) for each structure with an identification number greater than or equal to 0 (IDNO GE 0.) is tabulated using the PRINT command.

6. A count of the structures with value greater than $40,000 (VSTR GE 40000) is made with the command NUMBER.

7. The existing level of protection is tabulated for all structures that satisfy the last valid constraint (VSTR GE 40000). The level of protection is shown in years.

8. A count is obtained of structures with level of protection less than or equal to 15 years (LEVEL LE 15). Sixteen structures satisfy the constraint.

9. The constraints are combined.

10. An additional constraint is added. Three structures in the data bank satisfy the previous constraints and are identified as 1SNB (the input structure type).

11. A fourth constraint is added. Thus all one story, no basement structures in the 15-year flood plain, with value greater than or equal $40000, and with total expected annual damage greater than or equal $4000 are identified.

12. All structures that satisfy the previous constraint are listed by identification number (1001) and address (609 Second St.).

13. The structure summary for Structure 1001 is printed. The "current" and "without condition" elevations and structure attributes are tabulated.

14. The hazard summary is printed. This includes for various events the depths of flooding (measured relative to the ground floor at the structure). The recurrence interval, in years, of the event at the first floor is printed, and the level of protection is defined.

15. The economic summary is printed. This summary includes the specified values of the structure, its contents, and other property, the "current" EAD, the "without condition" EAD and the expected annual benefits of raising or protecting the structure (if it has been raised or protected).

16. The environmental summary is printed.

17. An invalid command is entered. The program responds by issuing an appropriate warning.

18. All structures that satisfy the last valid constraint (the combined constraint of item 10) are raised 1 foot with the RAISE command. A summary of updated values is printed for all revised structures. Here, for example, the level of protection increased from 2 years to 4.21 years.

19-21. The structure, economic, and hazard summaries for structure 1001 are again printed, reflecting the modifications to elevations, EAD values, and level of protection due to raising the structure.

22. The RESET command is entered to return the structure to its original elevation and to restore the economic and hazard indices to the original conditions.

23. The PROTECT command is used to protect the structure 1 foot. A summary of pertinent variables is printed.

25-27. The structure, economic, and hazard summaries are printed, with values modified by the use of the PROTECT command.

28. Program execution is terminated.

```
*****************************************************
*                                                   *
* PROGRAM FOR INTERACTIVE NONSTRUCTURAL ANALYSIS    *
*                                                   *
*****************************************************


TEST PROBLEM FOR PROGRAM FOR INTERACTIVE NONSTRUCTURAL ANALYSIS
JUNE 1981 VERSION
DEPTH-DAMAGE DATA BASED ON FIA DATA

**** COMMENT +++++ DEMONSTRATION OF PROGRAM CAPABILITIES +++++   (1)

**** HELP COMMAND (2)
COMMANDS
--------
REACH        READ DATA FOR SPECIFIED REACHES
LIST         LIST ID NUMBERS + TITLES OF FEASIBLE STRUCTURES
PRINT        PRINT ATTRIBUTE OR SUMMARY FOR FEASIBLE STRUCTURES
NUMBER       COUNT FEASIBLE STRUCTURES
RAISE        RAISE FEASIBLE STRUCTURES SO LOP ELEVATION = GROUND + DISTANCE
PROTECT      PROTECT FEASIBLE STRUCTURES SO LOP ELEVATION = GROUND + DISTANCE
SAVE         UPDATE DATA BANK FOR FEASIBLE STRUCTURES
TERMINATE    TERMINATE JOB
HELP         PRINT SUMMARY OF COMMANDS, CONSTRAINTS, ATTRIBUTES
COMMENT      PRINT (AND IGNORE) USER COMMENTS

**** HELP CONSTRAINTS (3)
CONSTRAINT FORMAT IS AS FOLLOWS
    ATTRIBUTE  CONDITION  RIGHT-HAND SIDE
ATTRIBUTE IS ANY OF THE VALID STRUCTURE ATTRIBUTES
CONDITION IS ONE OF THE FOLLOWING
     LE (LESS THAN OR EQUAL)
     EQ (EQUAL)
     GE (GREATER THAN OR EQUAL)
RIGHT-HAND SIDE IS ANY REASONABLE VALUE FOR COMPARISON
CONSTRAINTS CAN BE COMPOUNDED WITH AND AND OR


**** REACH 2 5 10 50 1000 (4)
REACH          2 READ.          4 STRUCTURES.
REACH          5 READ.          4 STRUCTURES.
REACH         10 READ.          4 STRUCTURES.
REACH         50 READ.          4 STRUCTURES.
REACH       1000 READ.          4 STRUCTURES.

REACHES READ       5
```

**** PRINT VSTR IDNO GE 0. 5

IDNO	VSTR
1001.	40000.00
1002.	50000.00
1003.	50000.00
1004.	80000.00
5001.	40000.00
5002.	50000.00
5003.	50000.00
5004.	80000.00
10009.	40000.00
10010.	50000.00
10011.	50000.00
10012.	80000.00
50013.	40000.00
50014.	50000.00
50015.	50000.00
50016.	80000.00
100001.	40000.00
100002.	50000.00
100003.	50000.00
100004.	80000.00
TOTAL	1100000.

**** NUMBER VSTR GE 40000. 6

20 FEASIBLE STRUCTURES

**** PRINT LEVEL 7

IDNO	LEVE
1001.	2.00
1002.	2.00
1003.	1.00
1004.	1.00
5001.	5.00
5002.	5.00
5003.	1.00
5004.	1.00
10009.	10.00
10010.	10.00
10011.	1.51
10012.	1.51
50013.	50.00
50014.	50.00
50015.	1.00
50016.	1.00
100001.	100.00
100002.	100.00
100003.	2.22
100004.	2.22

```
**** NUMBER LEVEL LE 15   8

 16 FEASIBLE STRUCTURES

**** NUMBER LEVEL LE 15 AND VSTR GE 40000   9

 16 FEASIBLE STRUCTURES

**** NUMBER LEVEL LE 15 AND VSTR GE 40000 AND TYPE EQ 1SNB   10

  3 FEASIBLE STRUCTURES

**** NUMBER LEVEL LE 15 AND VSTR GE 40000 AND TYPE EQ 1SNB AND EADT GE 4000.   11

  1 FEASIBLE STRUCTURES

**** LIST   12
  1001.609 SECOND ST.

**** PRINT STRUCTURE   13

STRUCTURE SUMMARY - STRUCTURE        1001.
609 SECOND ST.
                 CURRENT        W/C
  TOP ELEV        100.00      100.00
    GROUND        100.00      100.00
 1ST FLOOR        101.00      101.00
ZERO STAGE        100.00      100.00

       USE          RES
      TYPE          1SNB
PERMEABLTY          HIGH

                 OPENINGS
 BELOW 1ST            0.
    AT 1ST            2.
   WINDOWS            6.

FOUNDATION          RATS
FRAME MATL          WOOD
 SIDE MATL          WOOD
 CONDITION          GOOD
```

```
**** PRINT HAZARD  (14)

HAZARD SUMMARY - STRUCTURE      1001.
609 SECOND ST.
   REC INT      DEPTH
        2.       0.
        5.       1.17
       10.       1.86
       15.       2.20
       25.       2.66
       30.       2.83
       50.       3.26
       75.       3.63
      100.       3.86

        4.       1ST FLOOR
        2.       LEVEL OF PROT

PROTECTED        0.
RAISED           0.

**** PRINT ECONOMIC (15)

ECONOMIC SUMMARY - STRUCTURE      1001.
609 SECOND ST.
       TYPE       VALUE    CURRENT       W/O   EXP ANN
                               EAD       EAD   BENEFIT
  STRUCTURE   40000.00    4393.86   4393.86        0.
   CONTENTS   20000.00    3147.86   3147.86        0.
      OTHER    7500.00     129.98    129.98        0.
      TOTAL   67500.00    7671.70   7671.70        0.

**** PRINT ENVIRONMENTAL (16)

ENVIRONMENTAL SUMMARY - STRUCTURE      1001.
609 SECOND ST.
   ENVIRON       NONE
HISTORICAL       REGS

**** ELEVATE 1 (17)
INVALID COMMAND

**** RAISE 1 (18)
     IDNO       FFLE       PELE       SELE       EADC       EADS       EADT       LEVE
    1001.     102.00     101.00     101.00    1270.89    1935.20    3336.07       4.21
```

```
**** PRINT STRUCTURE   (19)

STRUCTURE SUMMARY - STRUCTURE        1001.
609 SECOND ST.
                    CURRENT        W/C
  LOP ELEV          101.00       100.00
    GROUND          100.00       100.00
 1ST FLOOR          102.00       101.00
ZERO STAGE          101.00       100.00

       USE          RES
      TYPE          1SNB
PERMEABLTY          HIGH

                    OPENINGS
 BELOW 1ST              0.
    AT 1ST              2.
   WINDOWS              6.

FOUNDATION          RATS
FRAME MATL          WOOD
 SIDE MATL          WOOD
 CONDITION          GOOD


**** PRINT ECONOMIC   (20)

ECONOMIC SUMMARY - STRUCTURE        1001.
609 SECOND ST.
      TYPE        VALUE     CURRENT          W/O     EXP ANN
                                FAD          EAD     BENEFIT
 STRUCTURE     40000.00     1935.20      4393.86     2458.66
  CONTENTS     20000.00     1270.89      3147.86     1876.97
     OTHER      7500.00      129.98       129.98          0.
     TOTAL     67500.00     3336.07      7671.70     4335.63

**** PRINT HAZARD   (21)

HAZARD SUMMARY - STRUCTURE        1001.
609 SECOND ST.
   REC INT        DEPTH
        2.        0.
        5.        1.17
       10.        1.96
       15.        2.20
       25.        2.66
       30.        2.93
       50.        3.26
       75.        3.63
      100.        3.86

       12.        1ST FLOOR
        4.        LEVEL OF PROT

PROTECTED         0.
RAISED            1.00
```

```
**** RESET (22)
      IDNO      FFLE       PELF       SFLE       EADC       EADS       EADT        LEVE
     1001.    101.00     100.00     100.00    3147.86    4393.86    7671.70        2.00

**** PRINT STRUCTURE (23)

STRUCTURE SUMMARY - STRUCTURE       1001.
609 SECOND ST.
                CURRENT       W/C
  LOP ELEV      100.00      100.00
    GROUND      100.00      100.00
 1ST FLOOR      101.00      101.00
ZERO STAGE      100.00      100.00

       USE        RES
      TYPE        1SNB
PERMEABLTY        HIGH

               OPENINGS
 BELOW 1ST          0.
    AT 1ST          2.
   WINDOWS          6.

FOUNDATION        RATS
FRAME MATL        WOOD
 SIDE MATL        WOOD
 CONDITION        GOOD


**** PROTECT 1 (24)
      IDNO      FFLE       PELF       SFLE       EADC       EADS       EADT        LEVE
     1001.    101.00     101.00     100.00    2253.12    2710.38    5093.48        4.21

**** PRINT STRUCTURE (25)

STRUCTURE SUMMARY - STRUCTURE       1001.
609 SECOND ST.
                CURRENT       W/C
  LOP ELEV      101.00      100.00
    GROUND      100.00      100.00
 1ST FLOOR      101.00      101.00
ZERO STAGE      100.00      100.00

       USE        RES
      TYPE        1SNB
PERMEABLTY        HIGH

               OPENINGS
 BELOW 1ST          0.
    AT 1ST          2.
   WINDOWS          6.

FOUNDATION        RATS
FRAME MATL        WOOD
 SIDE MATL        WOOD
 CONDITION        GOOD
```

**** PRINT ECONOMIC 26

ECONOMIC SUMMARY - STRUCTURE 1001.
609 SECOND ST.

TYPE	VALUE	CURRENT EAD	W/O EAD	EXP ANN BENEFIT
STRUCTURE	40000.00	2710.38	4393.86	1683.48
CONTENTS	20000.00	2253.12	3147.86	894.74
OTHER	7500.00	129.98	129.98	0.
TOTAL	67500.00	5093.48	7671.70	2578.22

**** PRINT HAZARD 27

HAZARD SUMMARY - STRUCTURE 1001.
609 SECOND ST.

REC INT	DEPTH
2.	0.
5.	1.17
10.	1.96
15.	2.20
25.	2.66
30.	2.83
50.	3.26
75.	3.63
100.	3.86
4.	1ST FLOOR
4.	LEVEL OF PROT

PROTECTED 1.00
RAISED 0.

**** TERMINATE 28

```
**************************************************************
*                                                            *
* PROGRAM FOR INTERACTIVE NONSTRUCTURAL ANALYSIS             *
*                                                            *
**************************************************************
```

GPO 687-010/48036